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GB 2087116 A GB 1217690 A EP 0535294 A1
EP 0478369 A2 EP 0138493 A2 EP 0113250 A2

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UK CL (Edition O) G4H HGA HGB HQF HQ2
INT CL[6] B41J , B65C

(54) **Tape printing apparatus and print head**

(57) The tape printing device has a print head which has a set of selectively activatable printing elements 120 arranged generally along a longitudinal axis of the print head. A rotatable platen is provided to cause relative movement between an image receiving tape and the print head to print an image on the tape. The printing elements of the print head are arranged in at least two groups 130,132,143 which are individually selectable. The groups are arranged so that selection of all the groups is required to activate all the printing elements of the set. Control circuitry controls the print head by generating a printing cycle which includes a respective predetermined activation period for each group of printing elements during which activation periods selected printing elements of the respective groups are activated. The predetermined activation periods occur at different times in the printing cycle and are evenly distributed throughout the printing cycle.

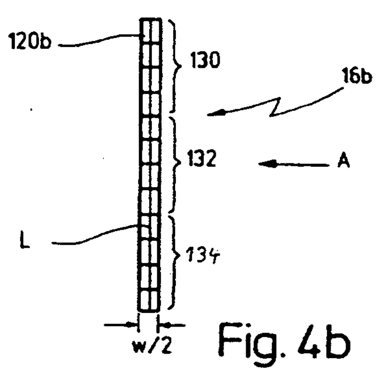

Fig. 4b

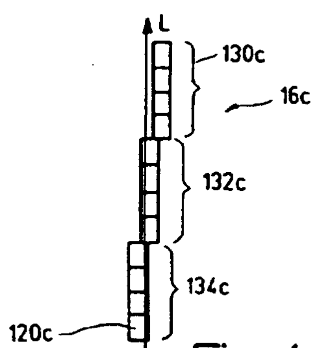

Fig. 4c

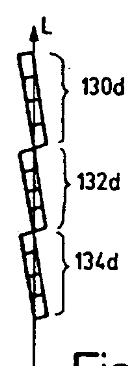

Fig. 4d

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The print reflects an assignment of the application under the provisions of Section 30 of the Patents Act 1977.

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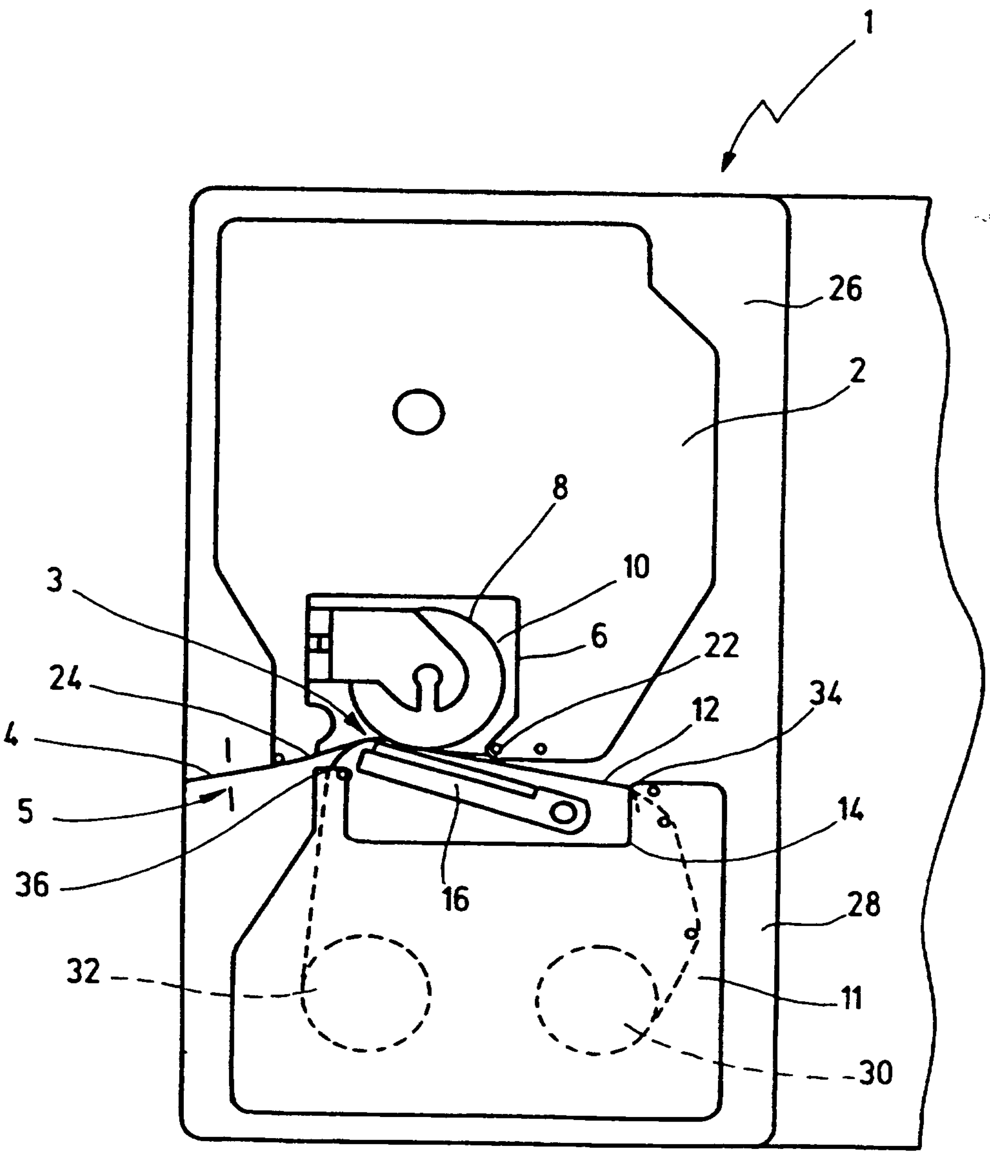


Fig. 1

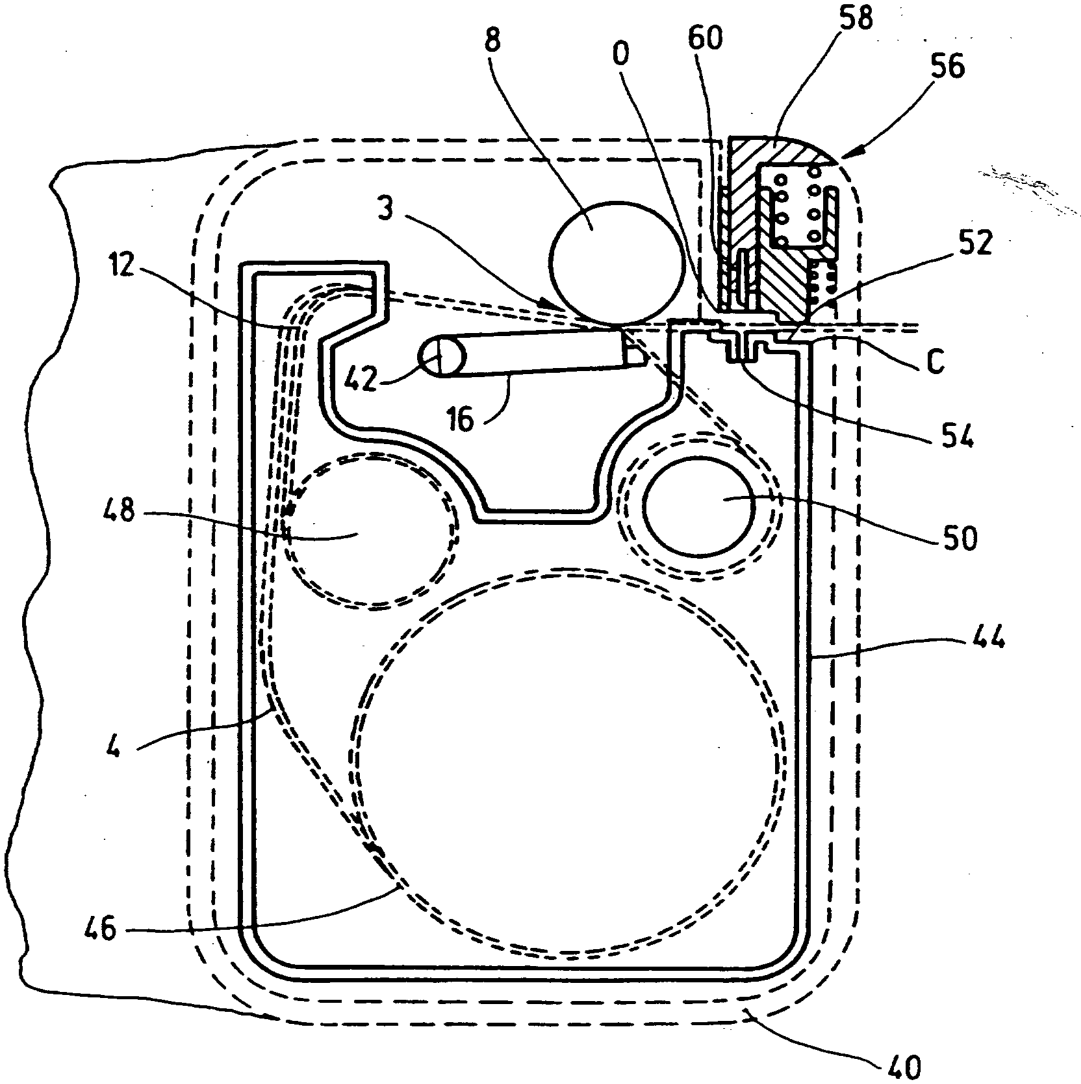


Fig. 2

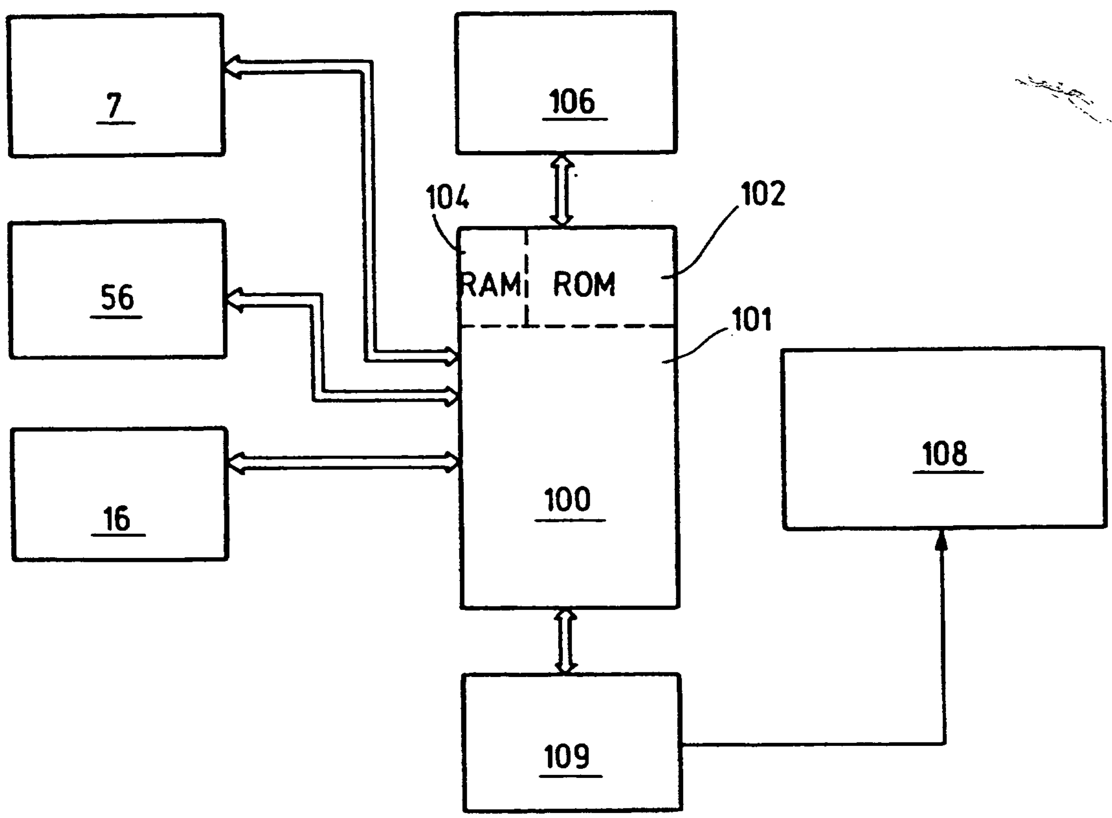


Fig. 3

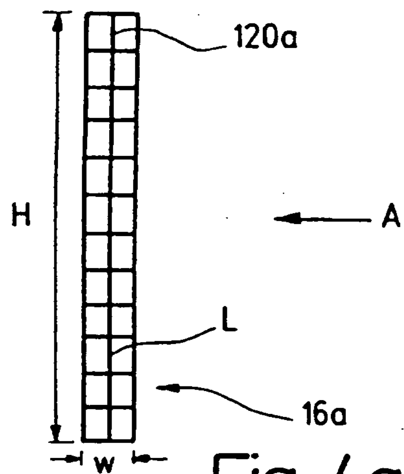


Fig. 4a

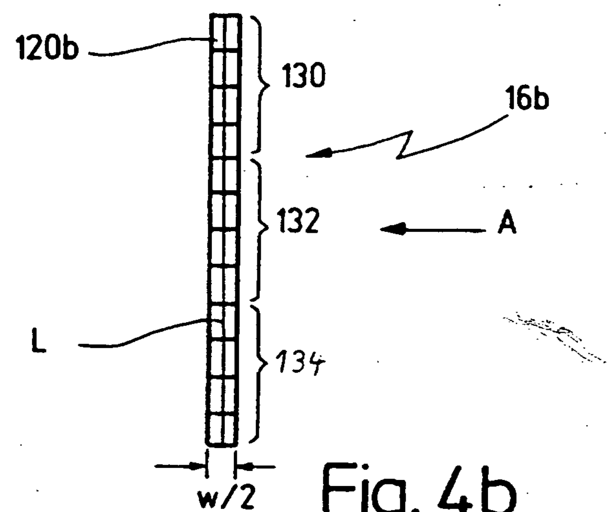


Fig. 4b

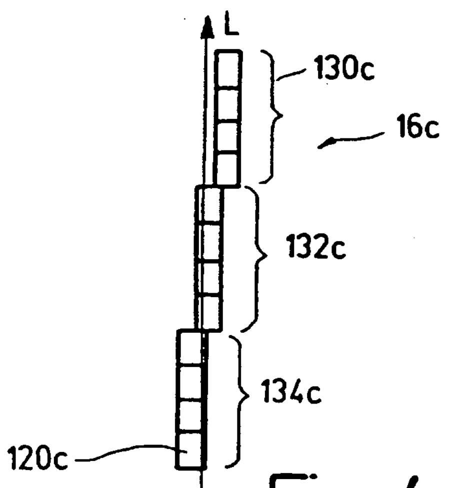


Fig. 4c

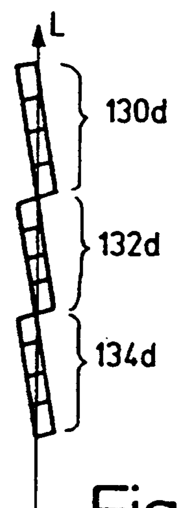
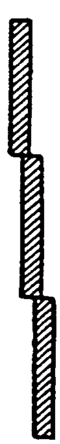


Fig. 4d



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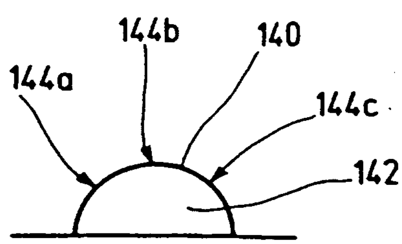

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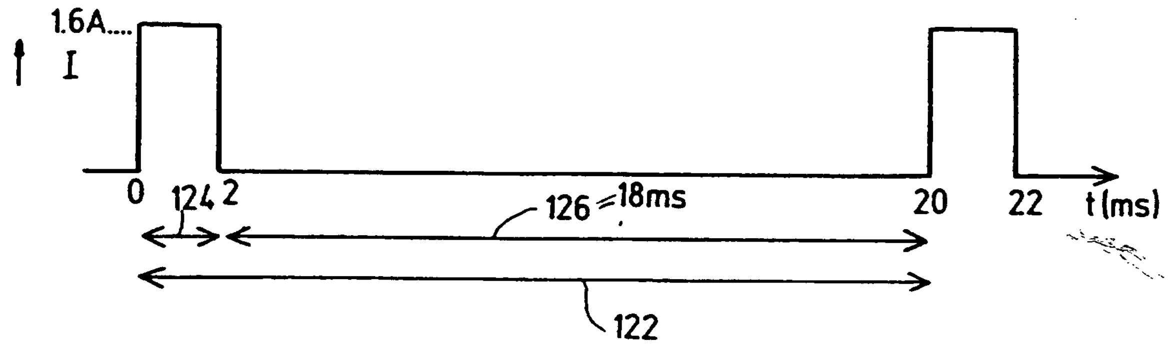


Fig. 5a

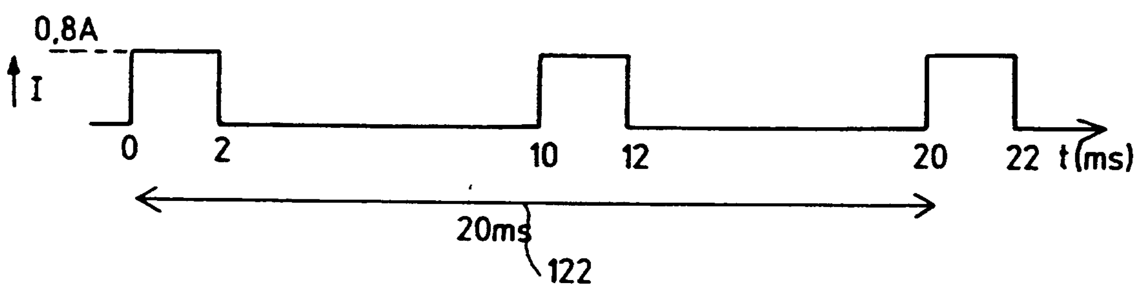


Fig. 5b

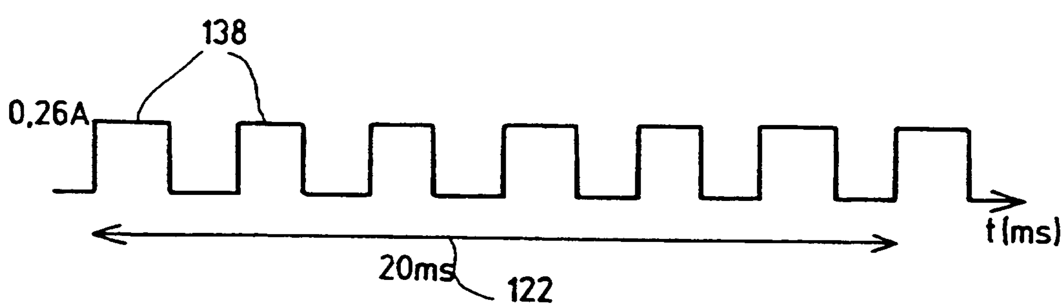
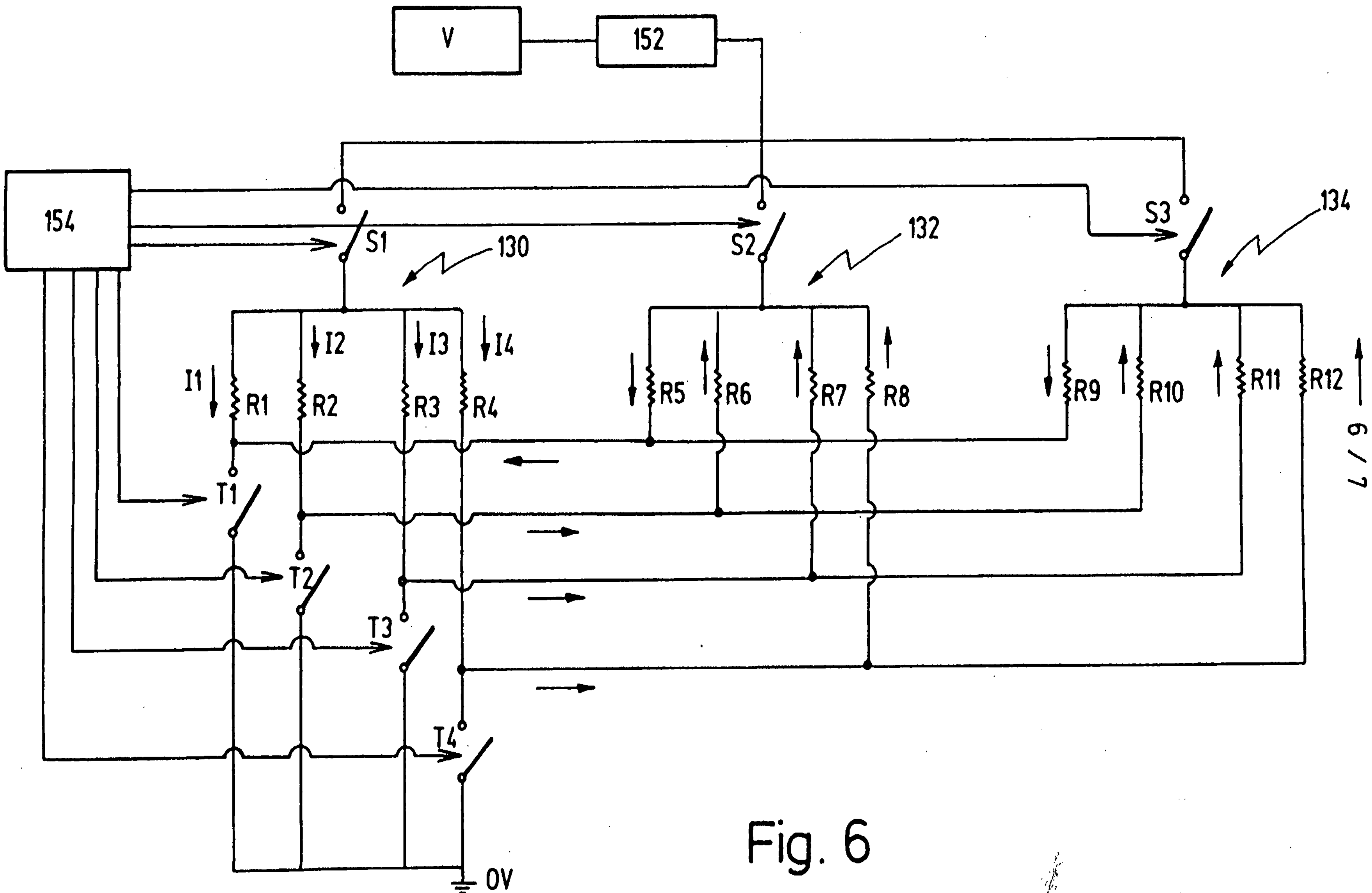


Fig. 5c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154
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S2
S3
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132
134
I1
I2
I3
I4
R1
R2
R3
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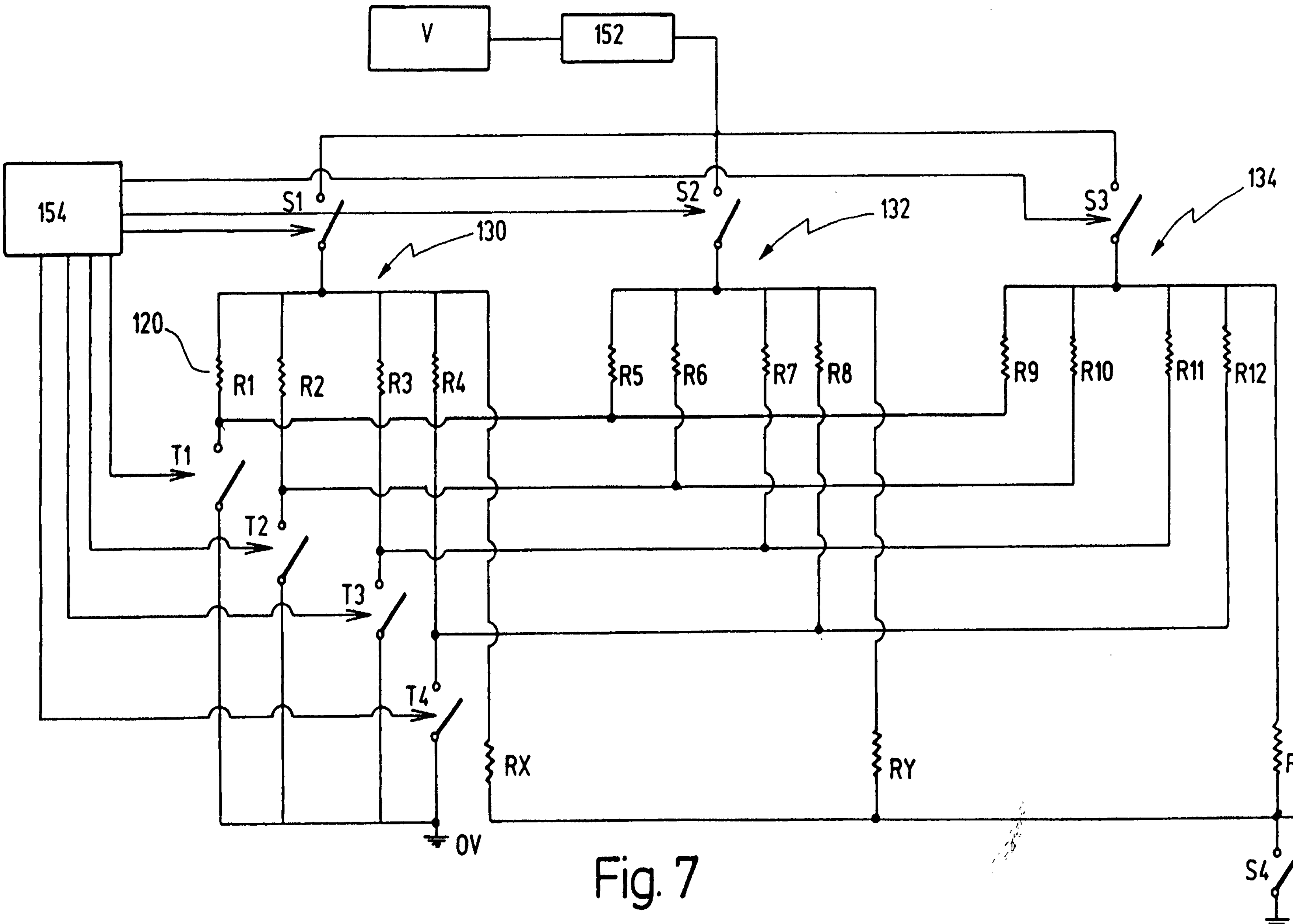
T3
T4
0V

Fig. 6


V
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S3
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R6
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R9
R10
R11
R12
T1
T2
T3
T4
RX
RY
RZ
0V
S4

Fig. 7

TAPE PRINTING APPARATUS AND PRINT HEAD

The present invention relates to a print head for a tape printing apparatus. The present invention also relates to the control of a print head.

Known tape printing apparatus of the type with which the present invention is concerned are disclosed in EP-A-322918 and EP-A-322919 (Brother Kogyo Kabushiki Kaisha) and EP-A-0267890 (Varitronics). The printers each include a printing device having a cassette receiving bay for receiving a cassette or tape holding case. In EP-A-0267890, the tape holding case houses an ink ribbon and a substrate tape, the latter comprising an upper image receiving layer secured to a backing layer by adhesive. In EP-A-322918 and EP-A-322919, the tape holding case houses an ink ribbon, a transparent image receiving tape and a double-sided adhesive tape which is secured at one of its adhesive coated sides to the image tape after printing and which has a backing layer peelable from its other adhesive coated side. With both these apparatus, the image transfer medium (ink ribbon) and an image receiving tape (substrate) are in the same cassette.

The present applicants have developed a different type of tape printing apparatus which is described for example in European Patent Application No. 578372, the contents of which are incorporated by reference. In this printing apparatus, the substrate tape is similar to that described in EP-A-0267890 but is housed in its own tape holding case while the ink ribbon is similarly housed in its own tape holding case.

In all of these cases, the image receiving tape passes in overlap with the ink ribbon to a print zone consisting of a fixed print head and a platen against which the print head can be pressed to cause an image to transfer from the ink ribbon to the image receiving tape. There are many ways of doing

this, including dry lettering or dry film impression, but the most usual way at present is by thermal printing where the print head is heated and the heat causes ink from the ink ribbon to be transferred to the image receiving tape.

The print head for such printing apparatus generally comprise a plurality of printing elements which are selectively activated, that is heated. The activated printing elements of the print head heat up which causes the ink from the parts of the ink ribbon in contact with the heated printing elements to be transferred to the image receiving tape. Alternatively, the heated printing elements may directly contact a thermally sensitive image receiving tape which causes an image to be formed thereon. These known print heads generally comprise a column of printing elements which have a height which corresponds generally to the width of the image receiving tape being used. All of the printing elements are arranged so as to be capable of being activated simultaneously, if necessary.

In use, the tape is moved past the print head and the print head is activated in cycles to provide the desired image on the image receiving tape. In particular, a typical cycle will last for 10 milliseconds. The printing elements, which are to be activated in that cycle are activated (i.e. heated) for 2 milliseconds of that cycle. Thus, for 8 milliseconds of the cycle, no printing element of the print head will be activated. This is to allow the power supply to recover and also to allow the print head to cool down. To be able to be capable of activating all the printing elements in the 2 millisecond part of the cycle, the apparatus is arranged to provide a relatively large maximum peak current. This is disadvantageous in that relatively high current peaks reduce the battery life. This is disadvantageous for those tape printing apparatus which are powered by batteries.

Additionally, in order to get the required current and voltage levels, a switching (high voltage) regulator is required which is relatively expensive. This can increase the costs of the tape printing apparatus as a whole.

In US-A-5072237, a thermal printer is described which has a plurality of thermal printing elements which are aligned in rows across a sheet of printing material. The thermal printer is powered by a battery which is unable to activate all of the printing elements simultaneously. Accordingly, the printer will determine how many thermal printing elements are required to be activated and divide the thermal printing elements into groups so that no more than one quarter of the total printing elements are activated at a given time. The number of groups is dependent on the number of thermal printing elements which are to be activated.

EP-A-619188 describes a thermal printer having a divided line print head. Typically, such print heads are required where the print head is greater than approximately 30cm long. The print head is controlled so as to avoid the appearance of lines in the printed image by randomly distributing print head element image data signals and complimentary element blanking signals in complimentary print line patterns among the overlapping sub-sets of printing elements.

According to a first aspect of the present invention there is provided a tape printing device comprising:

a print head having a set of selectively activatable printing elements arranged generally along a longitudinal axis of the print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape; and

control circuitry for controlling the print head, wherein

the printing elements are arranged in at least two groups which are individually selectable, the groups being arranged so that selection of all the groups is required to activate all printing elements of the set, said control circuitry controlling the print head by generating a printing cycle which includes a respective predetermined activation period for each group of printing elements during which activation periods selected printing elements of the respective groups are activated, wherein said predetermined activation periods occur at different times in said printing cycle and are substantially evenly distributed throughout said printing cycle.

By dividing the print head into at least two groups and activating those groups at different times in the printing cycle, the peak current applied to the printing elements can be reduced. This is because the current required is proportional to the area of the printing elements. Accordingly, if the print head is divided, for example into two groups which are activated at different times during the printing cycle, then the peak current required is halved. Additionally, evenly distributing the activation periods of the respective groups throughout the printing cycle has been found to increase the life of the battery. This is particularly advantageous when the power supply is in the form of one or more batteries. The peak current required can thus be made closer to the average current and preferably is less than three times greater than the average current over the printing cycle. Thus, this gives a smoother averaged current which means that a lower voltage supply can be used which reduces the cost of the tape printing apparatus as a whole. Additionally this extends the life of the batteries. Generally the greater the peak current, the shorter the battery life if energy drain is the same. By decreasing the peak current, battery life is lengthened.

In embodiments of the present invention, periods may be provided between successive activation periods in which the printing elements are not activated. These periods may allow the battery supply to recover.

Preferably, the print head is divided into three groups of printing elements. It has been found that three is the optimum number of groups of printing elements for certain embodiments of the invention. The printing elements of the same group may be arranged adjacent to one another along the longitudinal axis of the print head. Alternatively, the printing elements of one group may be interspersed by printing elements of at least one other group along the longitudinal axis of the print head.

Preferably, said image printed on said tape is in the form of a plurality of contiguous columns of pixels and said control circuitry controls the print head such that in each printing cycle selected ones of the printing elements are activated to print a line on the image receiving tape, wherein each pixel in a printed column is printed by generating a plurality of successive printing cycles to activate the same ones of the printing elements a corresponding plurality of times at contiguous locations on said image receiving tape.

According to a second aspect of the present invention, there is provided a tape printing device comprising:

a print head comprising a set of selectively activatable printing elements arranged generally along a longitudinal axis of the print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape in the form of a plurality of contiguous columns of pixels; and

control circuitry for controlling the print head by generating a plurality of printing cycles wherein in each

printing cycle selected ones of the printing elements are activated to print a line on the image receiving tape, wherein each pixel in a printed column is printed by generating a plurality of successive printing cycles to activate the same ones of the printing elements a corresponding plurality of times at contiguous locations on said image receiving tape.

As discussed above, the peak current is proportional to the area of the print head activatable at one given time. By reducing the size of each printing element of the print head so that activation of the same printing element in at least two successive cycles is required to define a pixel in the print image, it is again possible to reduce the peak current required giving rise to the advantages discussed above in relation to the first aspect.

Preferably each pixel is printed by generating two successive printing cycles to activate the same ones of the printing elements twice at contiguous locations on said tape. In other embodiments, the same printing elements may need to be activated three or four times in successive cycles to print a pixel.

The printing elements may be arranged in at least two groups which are individually activatable at different respective periods in a printing cycle. This further assists in reducing the peak current which results again in the advantages discussed in relation to the first aspect.

Each of said printing elements may be substantially rectangular and each pixel of the printed image may be substantially square.

It will be appreciated that features of the second aspect of the invention can be used in conjunction with those of the first aspect of the invention and vice versa.

For those embodiments which have a plurality of groups of printing elements which are activated at different points in the printing cycle, the image printed onto the image receiving tape may have a staggered effect resulting from different parts of the print head printing at different times during a printing cycle. This may occur with those embodiments where the image receiving tape is driven continuously past the print head by, for example, a DC motor. However, as will be appreciated, this difficulty can be avoided by using a stepper motor which allows the tape to remain stationary during a printing cycle and to be moved between cycles. In other embodiments of the invention, the staggered effect may not have a significant impact on the resulting image or the staggered effect may be within tolerable limits.

According to a third aspect of the present invention, there is provided a tape printing device comprising:

a print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape; and

control circuitry for controlling the print head,

wherein the print head comprises at least two groups of printing elements which are selectively activatable to provide an image on said image receiving tape, said groups of printing elements being arranged to be staggered with respect to each other, said control circuitry controlling the print head by generating a printing cycle which includes a predetermined activation period for each group of printing elements during which activation periods selected printing elements of the respective groups are activated, said predetermined activation periods occuring at different times in the printing cycle, wherein the staggering of the groups of printing elements is

arranged to substantially compensate for the activation periods for each group of printing elements occuring at different times in the printing cycle, relative to said movement.

Thus, the staggering effect caused by continuous movement of the image receiving tape past the print head may be compensated for. In particular, the stagger of the print head is preferably opposite to that of an image which would be obtained if a strictly linear print head with a plurality of groups of printing elements activated at different times were to be used with a continuously relatively moving image receiving tape. The activation of the staggered groups of printing elements of the print head may be controlled such that little or no stagger will be apparent in the printed image.

Preferably, each group of printing elements extends generally along a longitudinal axis of the print head as a whole. Preferably, the centres of said staggered groups lie along a line which defines an acute angle to a longitudinal axis of the print head as a whole. Complete compensation for staggering effects may be achieved with these embodiments. However, there may be disadvantages with this arrangement with those print heads which have the printing elements arranged on a semi-circular "glaze" bump. A print head is generally made up of a ceramic substrate on which resistive elements are deposited. These resistive elements are the printing elements of the print head. However in order to improve the contact between the image receiving medium and the printing elements, the resistive elements are deposited on top of a protective glaze. This glaze, has a generally semi-circular profile and extends generally in the direction of the longitudinal axis of the print head to thereby define a "glaze bump". With the groups of printing elements staggered with respect to one another in the manner discussed above, the centre of each

group of printing elements may be at different locations relative to the longitudinal axis of the glaze bump. This may, in certain embodiments affect the quality of print. However, it has been found that in certain embodiments of the invention this problem can be overcome by increasing the radius of the glaze bump.

Alternatively, it is proposed that each group of printing elements lie at an acute angle with respect to a longitudinal axis of the print head as a whole. A centre point of each group of printing elements preferably lies generally along a line extending generally along the longitudinal axis of the print head. This embodiment is advantageous in that the reduction in print quality which may result from print heads where the printing elements are arranged on a semi-circular "glaze" bump can be compensated for in that the centre of each group of pixels will have the same relationship to the longitudinal axis of the "glaze" bump. The staggering of the sections in this latter embodiment will reduce the appearance to the eye of staggering in the printed image, although full compensation will not generally be achieved.

Preferably, the acute angle is in the range of 0.1 to 1^{o} and preferably around $.38^{o}$.

It should be appreciated that the various embodiments having staggered print heads will each have applications to different situations and each have their own advantages.

Preferably, embodiments of the present invention use a low voltage linear regulator to provide a constant voltage. As embodiments of the present invention may reduce the peak current required, the power supply required can be reduced and accordingly a low voltage linear regulator can be used. A low voltage regulator has been found to perform satisfactorily

and, a high switching voltage regulator generally used in the prior art systems can be dispensed with. As low voltage linear regulators are generally cheaper than high voltage switching regulators, the cost of embodiments of the invention may be reduced.

As will be appreciated, the tape printing device described in the third aspect can incorporate features of the first and/or second aspect and vice versa.

According to a fourth aspect of the present invention, there is provided a print head comprising at least two groups of printing elements, said printing elements being selectively activatable to provide an image on a printing medium, said groups of printing elements being activatable at respective different times during a printing cycle, and control means comprising a common set of switches arranged to control the selective activation of printing elements in each group and group select means for selecting between the groups so that only one group of printing elements is activated at a given time.

DE-A-4438600 discloses a thermal printing device which has around 2560 printing elements which are arranged in four groups, which are controlled by respective strobe signals.

In known arrangements such as DE-A-4438600, generally a switch is provided for each printing element of the print head. However, with embodiments of the present invention the same switch means may be used to control the printing elements in each of the groups. The number of switches required may therefore be reduced, thus making the print head and consequently the apparatus less costly.

Preferably each switch of the common set of switches is arranged to control one printing element in each group. Thus, the number of switches required in said common set of switches is equal to the number of printing elements in each group.

The group select means preferably comprises a plurality of switches, equal to the number of groups of printing elements. Thus, each group is controlled by its own switch. In certain embodiments of the present invention, more than one group of pixels may be activated at a given time. In those circumstances, more than one of said switches of the group select means would be on.

Preferably, a diode is provided in series with each printing element to prevent unintended activation of a printing element. There may be parasitic currents which arise as a result of activation of selected printing elements and the introduction of a diode in series with each printing element will prevent unintended activation of a printing element, which is not to be activated, by a parasitic current.

The number of printing elements, the number of groups of printing elements, and/or the characteristics of the printing elements are selected such that the current passing through printing elements which are not to be activated may be maintained at a level below which activation of said printing elements does not occur. In this way, the need for a diode in series with each printing element may be avoided. It should be appreciated that in the context of this Application, "activation" of a printing element is defined as when the energy level applied to the printing element is sufficient for it to provide an image on a printing medium.

A resistive path may be provided for each group of printing elements, wherein each said path is arranged in parallel with the printing elements of the respective groups, said resistive path being arranged to steer current away from printing elements which are not to be activated to prevent accidental activation of the printing elements which are not to be activated. These resistive paths for each group may be controlled by a single switch. The group select means may control each of said groups of printing elements and the associated resistive paths. It should be appreciated that this latter arrangement is particularly suitable for those

embodiments which have three or more groups of pixels. The resistive paths may only be selected when the number of printing elements activated in a group is below a predetermined value.

It has been noted that the problems with parasitic currents are most pronounced where a certain number of printing elements in a group are not activated. The selective switching of the resistive paths allows these paths to reduce the problem so that parasitic activation of a printing element may be avoided.

As will be appreciated, the print head described in relation to the fourth aspect may incorporate features of one of more of the three previous aspects and vice versa.

The print head of the four above described aspects is preferably a thermal print head. The thermal print head is preferably only one printing element wide, at any given point and has a height corresponding to the maximum width of tape which is to be used with a tape printing apparatus. In practice, the print head height would be slightly less than the width of the tape as margins would be provided above and below the printing area on the tape. However, in certain embodiments of the invention, the height of the print head may be much less than the width of the tape.

According to a fifth aspect of the present invention, there is provided a method for controlling a tape printing device comprising a print head having a plurality of selectively activatable printing elements arranged generally along a longitudinal axis of the print head, said printing elements being arranged in at least two groups comprising the steps of:

causing relative movement between an image receiving tape and the print head to print an image on the tape;

activating selected printing elements of a first group of said printing elements at a first predetermined time in a printing cycle for the print head; and

activating the or each of the remaining groups of said printing elements at respective predetermined times in said printing cycle, different to said first predetermined time, wherein said predetermined activating times for said groups of pixels are substantially evenly distributed through said printing cycle.

For a better understanding of the present invention and as to how the same may be carried into effect, reference will now be made by way of example to the accompanying drawings in which:

Figure 1 is a plan view of a first tape printing device embodying the present invention using a two cassette system;

Figure 2 is a plan view of a second tape printing device embodying the present invention, using a one cassette system;

Figure 3 is a diagramatic sketch showing the control circuitry for the printing device of Figure 1 or of Figure 2;

Figure 4a shows a schematic view of a prior art print head;

Figure 4b shows a schematic view of a first print head embodying the present invention;

Figure 4c shows a schematic view of a second print head embodying the present invention;

Figure 4d shows a schematic view of a third print head embodying the present invention;

Figure 4e shows an image printed with the print head of Figure 4b;

Figure 4f shows a cross-sectional view through the print head of Figure 4c;

Figure 5a shows the relationship between current and time for the print head of Figure 4a;

Figure 5b shows the relationship between current and time for the print head of Figure 4b when operated in a first way;

Figure 5c shows the relationship between current and time for the print head of Figure 4b when operated in a second way;

Figure 6 shows a circuit diagram for the control of the print head shown in Figures 4b, 4c or 4d; and

Figure 7 shows a modified version of the circuit diagram shown in Figure 6 for the control of the print head shown in Figures 4b, 4c or 4d.

Figure 1 shows in plan view the first tape printing device 1 embodying the present invention which has two cassettes arranged therein. Typically this tape printing device 1 is a hand-held or small desk top device. The upper cassette 2 is located in a first cassette receiving portion 26 and contains a supply of image receiving tape 4 which passes through a print zone 3 of the tape printing device 1 to an outlet 5 of the tape printing device 1. The image receiving tape 4 comprises an upper layer for receiving a printed image on one of its surfaces and has its other surface coated with an adhesive layer to which is secured a releasable backing layer. The upper cassette 2 has a recess 6 for accommodating a platen 8 of the tape printing device 1, and guide portions 22, 24 for guiding the tape 4 through the print zone 3. The platen 8 is mounted for rotation within a cage moulding 10. Alternatively, the platen 8 could be mounted for rotation on a pin.

The lower cassette 11 is located in a second cassette receiving portion 28 and contains a thermal transfer ribbon 12 which extends from a supply spool 30 to a take up spool 32 within the cassette 11. The thermal transfer ribbon 12 extends through the print zone 3 in overlap with the image receiving tape 4. The cassette 11 has a recess 14 for receiving a print head 16 of the tape printing device 1 and guide portions 34, 36 for guiding the thermal transfer ribbon 12 through the print zone 3. The print head 16 is movable

between an operative position, shown in Figure 1, in which it is in contact with the platen 8 and holds the thermal transfer ribbon 12 and the image receiving tape 4 in overlap between the print head 16 and the platen 8 and an inoperative position in which it is moved away from the platen 8 to release the thermal transfer ribbon 12 and image receiving tape 4. In the operative position, the platen 8 is rotated to cause the image receiving tape 12 to be driven past the print head 16 and the print head 16 is controlled to print an image on to the image receiving tape 4 by thermal transfer of ink from the ribbon 12. The print head 16 will be described in more detail hereinafter but generally comprises a thermal print head having an array of printing elements each of which can be thermally activated in accordance with the desired image to be printed.

The tape printing device 1 has a lid, which is not shown but which is hinged along the rear of the cassette receiving portions 26 and 28 and which covers both cassettes when in place.

A DC motor 7 (see Figure 3) continuously drives the platen 8. The platen 8 is arranged to drive continuously the image receiving tape 4 through the print zone 3 by the action of its own rotation. Reference is hereby made to our European Patent Application No. 94308084.6 which describes the control of the DC motor and the contents of which are herein incorporated by reference.

The image is printed by the print head 16 on the image receiving tape on a column by column basis with the columns being adjacent one another in the direction of movement of the tape 4. The DC motor 7 is provided with a shaft encoder for monitoring the speed of rotation of the motor. Sequential printing of the columns of pixels by the print head 16 is

controlled in dependence on the monitored speed of rotation of the motor 7. The control of the speed of the motor 7 is achieved by the microprocessor chip 100 discussed in relation to Figure 3. The shaft encoder generates pulses that are frequency dependent on the speed of the motor 7 and the pulses cause the microprocessor chip 100 to generate data strobe signals each of which causes a column of pixel data to be printed by the print head 16.

Figure 2 illustrates in plan view a cassette bay of a second printing device 1' embodying the present invention which uses a one cassette system. Like reference numerals will be used for those parts also shown in Figure 1. The cassette bay is shown by the dotted line 40. The cassette bay 40 includes a thermal print head 16 and a platen 8 which cooperate to define a print zone 3. The print head 16 is pivotable about a pivot point 42 so that it can be brought into contact with the platen 8 for printing and moved away from the platen 8 to enable a cassette to be removed and replaced, as in the first embodiment. A cassette inserted into the cassette bay 40 is denoted generally by reference numeral 44. The cassette 44 holds a supply spool 46 of the image receiving tape 4. The image receiving tape 4 is guided by a guide mechanism (which is not shown) through the cassette 44, out of the cassette 44 through an outlet O, past the print zone 3 to a cutting location C. The same cassette 44 also has an ink ribbon supply spool 48 and an ink ribbon take up spool 50. The ink ribbon 12 is guided from the ink ribbon supply spool 48 through the print zone 3 and taken up on the ink ribbon take up spool 50. As with the first embodiment, the image receiving tape 4 passes in overlap with the ink ribbon 12 through the print zone 3 with its image receiving layer in contact with the ink ribbon 12.

The platen 8 of this second embodiment is also driven by a DC motor 7 (see Figure 3) so that it rotates to drive

continuously the image receiving tape 4 through the print zone 3 during printing. In this way, an image is printed on the tape and fed out from the print zone 3 to the cutting location C which is provided at a location on a portion of the wall of the cassette 44 which is close to the print zone 3. The portion of the wall of the cassette 44 where the cutting location C is defined is denoted by reference 52. A slot 54 is defined in the wall portion 52 and the image receiving tape 4 is fed past the print zone 3 to the cutting location C where it is supported by facing wall portions on either side of the slot 54.

The second tape printing device 1' includes a cutting mechanism 56 including a cutter support member 58 which carries a blade 60. The blade 60 cuts the image receiving tape 4 and then enters the slot 54.

The basic circuitry for controlling the tape printing device 1 of Figure 1 or the tape printing device 1' of Figure 2 is shown in Figure 3. There is a microprocessor chip 100 having a read only memory (ROM) 102, a microprocessor 101 and random access memory capacity indicated diagramatically by RAM 104. The microprocessor chip 100 is connected to receive label data input to it from a data input device such as a keyboard 106. The microprocessor chip 100 outputs data to drive a display 108 via a display driver chip 109 to display a label to printed (or a part thereof) and/or a message for the user. The display driver alternatively may form part of the microprocessor chip. Additionally, the microprocessor chip 100 also outputs data to drive the print head 16 so that the label data is printed on to the image receiving tape 4 to form a label. Finally, the microprocessor chip 100 also controls the DC motor 7 for driving the platen 8. The microprocessor chip 100 may also control the cutting mechanism 56 of Figure 2 or a cutting mechanism of Figure 1 to allow lengths of tape to be cut off.

The print head 16 shown in Figures 1 and 2 will now be described in more detail with reference to Figures 4 and 5. The type of print head 16 with which embodiments of the present invention are concerned generally comprise a plurality of printing elements 120 which are selectively heated to allow thermal printing to take place. This thermal printing can be directly on to thermally sensitive image receiving tape 4 or can be by means of an ink ribbon 12 such as shown in the embodiments of Figures 1 and 2. As discussed in relation to these embodiments, the ink ribbon 12 is arranged between the print head 16 and the image receiving tape 4. The application of heat to the ink ribbon 12 by selected printing elements 120 of the print head 16 causes an image to be transferred to the image receiving tape 4.

Before describing various print heads 16 embodying the present invention, the general construction of a known print head 16a will now be described with reference to Figures 4a and 5a. The known print head 16a comprises a plurality of printing elements 120a. In the schematic representation shown, there are twelve printing elements. However, actual print heads generally have many more printing elements, for example 128. The print head 16a generally has a height H slightly less than the width of the image receiving tape 4 to be used with the tape printing device 2. Where more than one width of tape is to be used with the tape printing device 2, the print head 16a will generally have a height H corresponding to the width of the largest image receiving tape 4 to be used with the tape printing device 12. Generally, the width W of the print head 16a is equal to the width of one printing element 120a to thereby form a column-shaped print head 16a. Each printing element 120a is generally square to print a square pixel on the image receiving tape.

Each printing element 120a is a resistive element which, when current is passed therethrough, is heated up. The

printing elements 120a are selectively heated so as to allow an image to be printed on to the image receiving tape 4 as it passes the print head 16a. The image printed on the image receiving tape 4 is defined by a plurality of contiguous or adjacent columns of pixels. Thus the image printed on the image receiving tape 4 depends on which printing elements 120a are activated or heated and when. The image receiving tape 4 moves generally in the direction of arrow A, that is in the lengthwise direction of the image receiving tape 4 and perpendicular to the longitudinal axis L of the print head 16a.

Reference will now be made to Figure 5a which shows the relationship between current and time for the print head 16a shown in Figure 4a. As can be seen, the print head 16a has a cycle 122 which comprises two parts. In the first part 124 of the cycle, current is applied to those printing elements 120a which are to be activated in that given cycle. It is possible that all elements of the print head 16a can be on or activated at the same time in the first part 124 of the cycle. For a 12 volt supply, the peak current will be 1.6 amps. Typically, the duration of the first part 124 of the cycle 122 is 2 milliseconds. The second part 126 of the cycle 122 is typically of 18 milliseconds duration giving a total cycle time of 20 milliseconds. The second part 126 of the cycle allows the power source to rest between applications of current to the printing elements 120a. The average current over the cycle is about .16 amps. As will be appreciated, the peak current is very much larger than the average current.

A first print head 16b embodying the present invention will now be described with reference to Figure 4b and Figure 5b. The print head 16b shown in Figure 4b is similar to that shown in Figure 4a. However, one difference relates to the shape and size of the printing elements 120b. In particular, instead of being generally square to provide a square pixel in the printed image as are the printing elements 120a of the known print head 16a, the printing elements 120b are generally

rectangular. In particular, the same printing elements 120b when activated twice, in succession, form a square pixel on the image receiving tape 4. In other words, each printing element 120b defines half a pixel in the printed image and is in the form of a half of a square. As printing elements 120b are resistive elements, the current required to heat the printing elements 120b shown in Figure 4b up to a desired temperature is proportional to the area of the printing element 120b. Accordingly, by halving the area of the printing element 120b, the current required to heat each printing element 120b is halved, for the same voltage. As will be appreciated all the printing elements of the print head 16b can be activated at the same time.

Reference is made to Figure 5b which shows the relationship between current and time for print head 16b. Thus, for a given cycle again of 20 milliseconds, current would be applied to the printing elements 120b of the print head twice in a given cycle to print one column of pixels on the image receiving tape 4. Each application of current would last approximately 2 milliseconds and would each have a peak current value of .8A. This would also give an average current of .16A. Thus, as compared to the embodiment shown in Figure 4a the peak current is halved but the average current remains unchanged. The printing elements 120b can also be in the form of one third or even one quarter of a square, which define a square pixel in the printed image when the same printing elements 120b are activated three or four times respectively in succession.

As discussed above, the image receiving tape 4 moves in the direction of arrow A past the print head. So as to improve the appearance of the image printed on to the image receiving tape 4, the speed of the image receiving tape 4 may, as compared to the prior art, be slowed down. This would reduce the average current over a printing cycle as the length

of the printing cycle is effectively increased. Typically, the image receiving tape 4 may move at a speed of 7 millimetres per second past the print head 16b. However, it would be possible for the image receiving tape 4 to move more quickly or more slowly than this past the print head 16b.

The embodiment shown in Figure 4b can be modified so as to divide the print head 16b into three sections 130, 132 and 134. For illustrative purposes, each section 130, 132 and 134 has four printing elements 120b only. In one preferred embodiment, each section 130, 132 and 134 may have thirteen printing elements. The three sections 130, 132 and 134 are arranged so as to be activated or strobed consecutively. In other words, in a given cycle the selected printing elements 120b of the first section 130 are first activated. Subsequently, the selected printing elements 120b of section 132 are activated and finally, the selected printing elements 120b of the third section 134 are activated. Thus, at any one time, a maximum of one third of all the printing elements 120b of the print head 16b are activated. The relationship between current and time for this modified embodiment of Figure 4b is shown in Figure 5c. As can be seen from Figure 5c, the three sections 130, 132 and 134 of the print head 16b are strobed or activated at equally spaced intervals across the cycle 122. In particular, there are six periods 138 in which current is applied to respective sections 130, 132 and 134 of printing elements 120b. The peak current for the printing elements 120b would be one sixth of that shown in Figure 5a because the printing elements 120b are half the size of those of Figure 4a and only one third of the printing elements 120b can be energised or activated at any given time. The average current will be the same as in Figure 4b as the print head 16b in its entirety is activated twice in each printing cycle. Where the printing elements are "full sized" and need only be activated once to provide a pixel on the tape, then each group of printing elements may only be activated once in a printing cycle.

As will be appreciated, the printing elements 120b need not be rectangular in the modified print head 16b shown in Figure 4b and discussed in relation to Figure 5c but can of course also be generally square as in the prior art.

As the image receiving tape 4 continually moves past the print head 16b in the direction of arrow A, use of a print head 16b such as shown in Figure 4b, with the three sections 130, 132 and 134 energised or strobed in sequence will provide an image on the image receiving tape 4 which is staggered, such as shown in Figure 4e. For some embodiments, this stagger may not have a significant impact on the quality of printing. However, for those embodiments where it is desired to improve the quality of printing, the print head shown in Figure 4c may be used. The print head 16c has three sections 130c, 132c and 134c which are staggered with respect to each other in a direction opposite to that of the image which would be produced by the print head 16b as shown in Figure 4e. Each section 130c, 132c, 134c is made up of four printing elements 120c similar to those shown in Figure 4b. As with the print head 16b shown in Figure 4b, the printing elements 120c in section 130c are activated first followed by the printing elements 120c in section 132c followed finally by the printing elements 120c in section 134c. As the image receiving tape 4 is moving in the direction of arrow A, the stagger in the image printed with the print head 16b of Figure 4b can be corrected. In particular, the print head 16c is designed, to take into account the speed of the tape 4, so that when the second section 132c is ready to print, that section 132c prints an image directly underneath, and in line, with that printed by section 130c of the print head 16c. Likewise, the third section 134c is arranged to print an image directly below and in line with that printed by the first and second sections 130c and 132c. In certain embodiments, the stagger between two adjacent sections 130c, 132c and 134c may be equal

to one third the pitch between adjacent printing positions. This may be slightly less than one third of the width of each printing element. The printing elements 120c may be the same as those shown in respect of Figure 4a or 4b.

When the print head 16c is viewed in cross-section such as shown in Figure 4f, it can be seen that the printing elements 120c of the print head 16 actually lie on along the top 140 of a "glaze bump" 142. A print head is generally made up of a ceramic substrate on which resistive elements are deposited. These resistive elements are the printing elements of the print head. However in order to improve the contact between the printing medium and the printing elements, the resistive elements are deposited on top of a glaze. This glaze has a generally semi-circular profile and extends generally in the direction of the longitudinal axis L of the print head 16 to thereby define a "glaze bump". With a staggered print head 16c such as shown in Figure 4c, the centre of the printing elements 120c of the respective sections 130c, 132c and 134c will be at different locations on the glaze bump 142 for example at locations 144a, 144b and 144c. Accordingly, the printing elements of each section 130c, 132c and 134c will have a different relationship with the platen 8 against which the print head 16c acts. This may affect the quality of printing although with some embodiments of the invention, this problem may be negligible. In some embodiments of the invention, the radius of the glaze bump 142 may be increased which may improve the quality of print.

The print head 16d shown in Figure 4d has been proposed to address this problem. In this embodiment each section of 130d, 132d and 134d is angled at between 0.1 - 1^{o} and preferably around $.38^{o}$, with respect to the longitudinal axis L of the print head 16d. However, all the centres 133a, 133b and 133c respectively of sections 130d, 132d and 134d lie along the longitudinal axis L of the print head 16d. Whilst a complete compensation for the stagger is not achieved with the print head 16d, the appearance of stagger to the eye in the printed image is reduced as compared with the print head 16b of Figure 4b. Additionally, it is also possible with the print head 16d to avoid a potential reduction in print quality which may be apparent with the print head 16c of Figure 4c. However, it will be appreciated, that there are embodiments of the present invention where the print heads 16b, 16c and 16d shown in Figures 4b, 4c and 4d will each have particular advantages.

The relationship between the current and time for the print heads shown in Figures 4c and 4d is the same as that shown in Figure 5c.

For the purposes of comparison, it has been assumed in the above discussion that all of the print heads 16a, 16b, 16c and 16d shown in Figure 4 have the same supply voltage and cycle time. However, Table 1 shows actual values of various parameters for embodiments of the present invention and the prior art.

Table 1

Print Head	Supply Voltage	Peak Current/ Duration	Average I	Cycle Length
16a (Prior Art - Figure 4a)	12V	1.6A/2ms	0.32A	10ms
16b (1/2 rectangles Figure 4b)	12V	.8/2ms	0.32A	10ms
16b/16c/16d (3 sections + 1/2 rectangles Figures 4b, 4c, 4d)	5V	0.67A/2ms	0.38A	21ms

As can be seen from Table 1, embodiments of the present invention are able to activate the print heads 16b, 16c and 16d with smaller peak currents as compared to the prior art embodiment. Alternatively, if the peak current remains comparable with the prior art arrangements, the voltage requirements can be reduced. The embodiments of Figures 4b to 4d are thus able to reduce the peak current to average current ratio as compared to the prior art shown for example in Figure 4a to thereby give a smoother averaged current across the printing cycle. In other words, the peak current is closer to the average current and preferably less than three times larger.

Reference will now be made to Figure 6 which illustrates the control of the printing elements 120 of print head 16 shown in Figures 4b, 4c or 4d.

As discussed above, each printing element 120b generally comprises a resistive element. Accordingly, the printing elements 120 are represented in Figure 6 by resistors R1 - R12. The printing elements 120 or resistors R1 - R12 are grouped in three groups of four. These three groups represent sections 130, 132 and 134 respectively of the print head 16b, 16c and 16d. Each section 130, 132 and 134 is connected to the print head voltage supply V via respective switches S1, S2 and S3 which define group select switches. Thus, a switch S1, S2 and S3 is provided for each section 130, 132 and 134 of the print head 16. These switches can take any suitable form and are preferably either bipolar transistors or FETs.

The first resistors R1, R5 and R9 of each section 130, 132 and 134 are all connected together. Likewise, the second resistors R2, R6 and R10 are connected together as are the third resistors R3, R7 and R11 of each section 130, 132 and 134. Finally, the fourth resistors R4, R8 and R12 of each section 130, 132 and 134 are all connected together.

The first resistors R1, R5 and R9 of each section 130, 132 and 134 are connected to switch T1, the second resistors R2, R6, R10 of each section 130, 132 and 134 are connected to switch T2, the third resistors R3, R7 and R11 being connected to switch T3 and finally, the fourth resistors R4, R8 and R12 of each section 130, 132 and 134 are connected to switch T4. As with switches S1 to S3, switches T1 to T4 are preferably bipolar transistors or FETs. However, any other suitable switching device can be used. Switches T1 to T4 define a common set of switches which are arranged to control the selective activation of printing elements 120 in each group 130, 132 and 134.

The switches T1 to T4 are all in parallel with one another as are resistors R1 to R12. The switches T1 to T4 are

all connected to ground. The switches T1 to T4 and S1, S2 and S3 are all controlled by a controller 154 which may be the microprocessor 100. Alternatively a separate controller can be provided which may form part of the print head 16. Means may, if necessary be provided for converting the serial output of the microprocessor into a parallel output. Alternatively, a parallel output may be provided by the microprocessor 100. The arrangement shown in Figure 6 allows a multiplexed driving of the print head 16 which can simplify the control of the printing elements 120. Particular embodiments of the invention can dispense with a print head controller present on print heads of the prior art, reducing the cost of the print head 16. The control can be simply achieved as outlined above by use of the microprocessor.

The print head voltage supply V comprises a battery source which typically comprises six 1.5 volt batteries giving a total supply of nine volts. The voltage supply V is connected to a low voltage linear regulator 152 which provides a constant voltage of around five volts. The low voltage linear regulator 152 steps down the voltage to the required five volt level. A nine volt supply is required so that it can be ensured that there is always a five volt supply as the linear regulator 152 requires a certain "drop out" voltage to operate. Additionally, the battery voltage level will decrease during the printing operation.

The operation of the circuit shown in Figure 6 will now be described. The switches S1, S2 and S3 are energised or strobed, that is turned on by successive strobe pulses provided by the controller 154. In this way, the print head sections 130, 132 and 134 are energised one at a time. As only one of these switches S1, S2 or S3 is closed or on at any given time, only one section 130, 132 and 134 of the print head will be energised at a given time. The switches T1 to T4 are selectively closed i.e. turned on depending on which of the printing elements 120 of the energised section 130, 132

and 134 are to be activated. Thus, all of the switches T1 to T4 may be off, all of the switches T1 to T4 may be on or only some of the switches T1 to T4 may be on. In other words, the switches T1 to T4 determine which printing elements 120 are activated in each section 130, 132 and 134 of the print head as each of these sections 130, 132 and 134 is successively activated. If, for example, section 130 is energised by switch S1 being closed and printing element R1 is to be activated, then switch T1 will be closed. If, on the other hand, printing element R1 is not to be activated, then switch T1 will remain open i.e. off. In this way, the individual printing elements 120 can be controlled by means of switches T1 to T4.

As will be appreciated, the total number of switches required equals N/M + M where N equals the number of printing elements 120 and M equals the number of sections 130, 132 and 134 into which the print head 16 is divided. As will be appreciated, this reduces the number of switches required as compared to the prior art which requires a switch for each individual printing element.

The following situation will now be considered. Switch S1 is on, S2 and S3 are off. Switch T1 is on and switches T2, T3 and T4 are all off. The arrows in Figure 6 show the direction of the various currents which arise in the circuit. Curent I1 is the activation current which activates printing element R1. I2, I3 and I4 are all parasitic currents. These parasitic currents may cause printing elements 120 which should not be activated to be activated. These printing elements may be in a section 132 and 134 which is inactive or in section 130 which is active.

In one embodiment of the present invention, a diode is placed in series with each of the resistive elements R1 to R12. These diodes are able to prevent parasitic currents in

the circuit. However, whilst this solution is used in certain embodiments of the invention, diodes increase the number of components required which is obviously disadvantageous. Additionally, the number of diodes which would be required would undesirably increase the cost of the apparatus.

It has been ascertained that a printing element 120 will not print if the energy level applied to a printing element i.e. a current flowing therethrough is below a given level. Experimentally, it has been determined that in some embodiments of the invention printing will not occur if the energy level applied to the printing element 120 is less than 40% of the normal printing energy level required. Thus, if the circuit shown in Figure 6 is designed so parasitic currents such as I2, I3 and I4 do not exceed a level which activates the relevant printing element 120 to an energy level greater than 40% of the normal printing energy, then the unintended activation of printing elements 120 which should not be activated can be avoided. In those embodiments, the presence of diodes would not be necessary. Factors which affect the current levels in unactivated printing elements may include one or more of the following: the number of printing elements; the number of groups of printing elements; and/or the characteristics (such as resistance or the like) of the printing elements.

This latter arrangement has been found to be particularly advantageous where M is around 3 and N does not exceed around 24. Such embodiments of the present invention, which have the print head divided into three have been found to be advantageous in that the amount of wasted energy is minimised, parasitic currents do not exceed the 40% energy level and a reduction in the peak current can also be achieved.

Reference will now be made to Figure 7 which shows a modification to the circuit shown in Figure 6. The circuit

shown in Figure 7 is the same as that shown in Figure 6 with the addition of three further resistors RX, RY and RZ. RX is connected to switch S1 and is arranged in parallel with resistors R1 to R4. RY is connected to switch S2 and is connected in parallel with resistors R5 to R8. Finally, RZ is connected to switch S3 and is arranged in parallel with resistors R9 to R12. The resistors RX, RY and RZ are connected in parallel and are connected to a further switch S4 which itself is connected to the ground. The switch S4 is also controlled by controller 154.

The embodiment shown in Figure 7 is particularly advantageous where the parasitic currents are such that they may cause activation of printing elements 120, which should be unactivated by supplying an energy level greater than 40% of the normal printing energy. The levels of parasitic currents which could cause problems typically arise when only a few of the printing elements R1 to R12 are activated in a selected section 130, 132 and 134 of the print head 16. As discussed above, if the printing elements 120 are activated to an energy level which is greater than 40% of the normal printing energy, then unwanted activation of a printing elements 120 which should not be activated can occur. Resistors RX, RY and RZ are provided so as to steer current away from printing elements 120 that could print parasitically. In particular, when there is a risk of parasitic printing, as in the circumstances discussed above, switch S4 is turned on. Current then preferentially flows through RX, RY and RZ and away from those printing elements that could parasitically print. The resistive values of RX, RY and RZ are generally lower than those of the printing elements R1 to R12. The optimum value of RX, RY and RZ can be ascertained experimentally by trial and error. With the presence of the resistors RX, RY and RZ and switch S4 on, any parasitic currents flowing through printing elements 120 which are not

to be activated during a given cycle can be maintained below the 40% threshold value. In some embodiments, the switch S4 could be dispensed with and the resistors RX, RY and RZ would always provide an alternative path, thus reducing the risks of parasitic printing. However, this may unnecessarily waste energy which is why preferred embodiments use switch S4 to limit the use of the resistive paths defined by RX, RY and RZ to situations in which there is an actual risk of parasitic printing.

The embodiment shown in Figure 7 is particularly suited to those embodiments which have, typically, more than 24 printing elements 120. In this way, the need for diodes, such as discussed above, can be avoided. However, diodes may also be used with such an arrangement.

As will be appreciated, there are several modifications possible to the embodiments described. For example, the DC motor could be replaced by a stepper motor. In those circumstances, movement of the tape could be in a stepwise fashion. Thus, with the stepper motor, the staggered print head shown in Figures 4c and 4d may be dispensed with. However, the activation of separate sections of the print head at different times is advantageous in those embodiments which use a stepper motor.

In the embodiments shown, the print head is divided up into three sections which are successively activated. However, the print head can of course be divided up into any other number of suitable sections. Additionally, the printing elements in each section need not be adjacent to each other. For example, alternate printing elements may be selectively activated and define the respective sections respectively. With these latter embodiments, the effects due to staggering may be less apparent.

CLAIMS:

1. A tape printing device comprising:

a print head having a set of selectively activatable printing elements arranged generally along a longitudinal axis of the print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape; and

control circuitry for controlling the print head, wherein the printing elements are arranged in at least two groups which are individually selectable, the groups being arranged so that selection of all the groups is required to activate all printing elements of the set, said control circuitry controlling the print head by generating a printing cycle which includes a respective predetermined activation period for each group of printing elements during which activation periods selected printing elements of the respective groups are activated, wherein said predetermined activation periods occur at different times in said printing cycle and are substantially evenly distributed throughout said printing cycle.

2. A tape printing device as claimed in claim 1, wherein three groups of printing elements are provided.

3. A tape printing device as claimed in claim 1 or 2, wherein the printing elements of the same group are arranged adjacent to one another along the longitudinal axis of the print head.

4. A tape printing device as claimed in claim 1 or 2, wherein the printing elements of one of said groups are interspersed by printing elements of said at least one other group along the longitudinal axis of the print head.

5. A tape printing device as claimed in any preceding claim, wherein said image printed on said tape is in the form of a plurality of contiguous columns of pixels and said control circuitry controls the print head such that in each printing cycle selected ones of the printing elements are activated to print a line on the image receiving tape, wherein each pixel in a printed column is printed by generating a plurality of successive printing cycles to activate the same ones of the printing elements a corresponding plurality of times at contiguous locations on said image receiving tape.

6. A tape printing device comprising:

a print head comprising a set of selectively activatable printing elements arranged generally along a longitudinal axis of the print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape in the form of a plurality of contiguous columns of pixels; and

control circuitry for controlling the print head by generating a plurality of printing cycles wherein in each printing cycle selected ones of the printing elements are activated to print a line on the image receiving tape, wherein each pixel in a printed column is printed by generating a plurality of successive printing cycles to activate the same ones of the printing elements a corresponding plurality of times at contiguous locations on said image receiving tape.

7. A tape printing device as claimed in claim 6, wherein each pixel is printed by generating two successive printing cycles to activate the same ones of the printing elements twice at contiguous locations on said tape.

8. A tape printing device as claimed in claim 6 or 7, wherein said printing elements are arranged in at least two groups which are individually activatable at different respective periods in a printing cycle.

9. A tape printing device as claimed in claim 5, 6, 7 or 8, wherein each of said printing elements is substantially rectangular and each pixel of the printed column is substantially square.

10. A tape printing device as claimed in any one of claims 1 to 5, 8 or 9, wherein said groups of printing elements are arranged to be staggered with respect to each other, whereby when said print head is arranged to print an image on an image receiving tape which continuously moves relative to said print head, the staggering of the groups of printing elements is arranged to substantially compensate for the activation period for each group of printing elements occuring at different times in said printing cycle, relative to said movement.

11. A tape printing device comprising:

a print head;

means for causing relative movement between an image receiving tape and the print head to print an image on the tape; and

control circuitry for controlling the print head,

wherein the print head comprises at least two groups of printing elements which are selectively activatable to provide an image on said image receiving tape, said groups of printing elements being arranged to be staggered with respect to each other, said control circuitry controlling the print head by generating a printing cycle which includes a predetermined activation period for each group of printing elements during which activation periods selected printing elements of the respective groups are activated, said predetermined activation periods occuring at different times in the printing cycle, wherein the staggering of the groups of printing elements is arranged to substantially compensate for the activation periods for each group of printing elements occuring at different times in the printing cycle, relative to said movement.

12. A tape printing device as claimed in claim 10 or 11, wherein each group of printing elements extends generally along a longitudinal axis of the print head.

13. A tape printing device as claimed in claim 10 or 11, wherein each group of printing elements lies at an acute angle with respect to a longitudinal axis of the print head.

14. A tape printing device as claimed in claim 13, wherein said acute angle is in the range of 0.1 to 1^{o}.

15. A tape printing device as claimed in claim 13 or 14, wherein a centre point of each group of printing elements lies along a line extending generally along the longitudinal axis of the print head.

16. A tape printing device as claimed in any preceding claim, wherein a low voltage linear regulator is used to provide a constant voltage for the print head.

17. A tape printing device as claimed in any preceding claim, wherein a peak current applied to said print head is less than three times the average current over a printing cycle of the print head, for the case where all printing elements are activated in a printing cycle.

18. A print head comprising at least two groups of printing elements, said printing elements being selectively activatable to provide an image on a printing medium, said groups of printing elements being activatable at respective different times during a printing cycle, and control means comprising a common set of switches arranged to control the selective activation of printing elements in each group and group select means for selecting between the groups so that only one group of printing elements is activated at a given time.

19. A print head as claimed in claim 18, wherein each switch of the common set of switches is arranged to control one printing element in each group.

20. A print head as claimed in claim 18 or 19, wherein said group select means comprises a plurality of switches, equal to the number of groups of printing elements.

21. A print head as claimed claim 18 or 19, wherein a diode is provided in series with each printing element to prevent unintended activation of a printing element.

22. A print head as claimed in any of claims 18 to 21, wherein the number of printing elements, the number of groups of printing elements, and/or the characteristics of the printing elements are selected such that the current passing through said printing elements which are not to be activated is maintained at a level below which said printing elements cannot print an image.

23. A print head as claimed in any of claims 18 to 22, wherein a resistive path is provided for each group of printing elements, each said path being arranged in parallel with the printing elements of the respective groups, said resistive path being arranged to steer current away from printing elements which are not to be activated to prevent accidental activation of the printing elements which are not to be activated.

24. A print head as claimed in claim 23, wherein said group select means controls each of said groups of printing elements and the associated resistive paths.

25. A print head as claimed in claim 23 or 24, wherein said resistive paths are controlled by a single switch.

26. A print head as claimed in claim 24, wherein said resistive paths are only selected when the number of printing elements activated in a group is below a predetermined value.

27. A method for controlling a tape printing device comprising a print head having a plurality of selectively activatable printing elements arranged generally along a longitudinal axis of the print head, said printing elements being arranged in at least two groups comprising the steps of:

causing relative movement between an image receiving tape and the print head to print an image on the tape;

activating selected printing elements of a first group of said printing elements at a first predetermined time in a printing cycle for the print head; and

activating the or each of the remaining groups of said printing elements at respective predetermined times in said printing cycle, different to said first predetermined time, wherein said predetermined activating times for said groups of pixels are substantially evenly distributed through said printing cycle.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17
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Relevant Technical Fields

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Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1, 27 PLUS APPENDANCIES

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2087116 A	(SONY)	1, 27 at least
X	GB 1217690	(CREED)	1, 27 at least
X	EP 0535294 A1	(SEIKO)	1, 27 at least
X	EP 0478369 A2	(FUJITSU)	1, 27 at least
X	EP 0318493 A2	(ISHIDA)	1, 27 at least
X	EP 0113250 A2	(MITSUBISHI)	1, 27 at least

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